

# Laser Safety Program at NASA LaRC

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# Background

- LaRC is primarily an aeronautics and atmospheric science research center although we are involved in the ARES and CEV projects
- LaRC has over 75 active laser safety permits
  - Some permits cover only one laser some may cover as many as a dozen lasers
- We have approximately 375 registered laser workers although probably only half are actively involved in using or being around lasers.

# Program basics

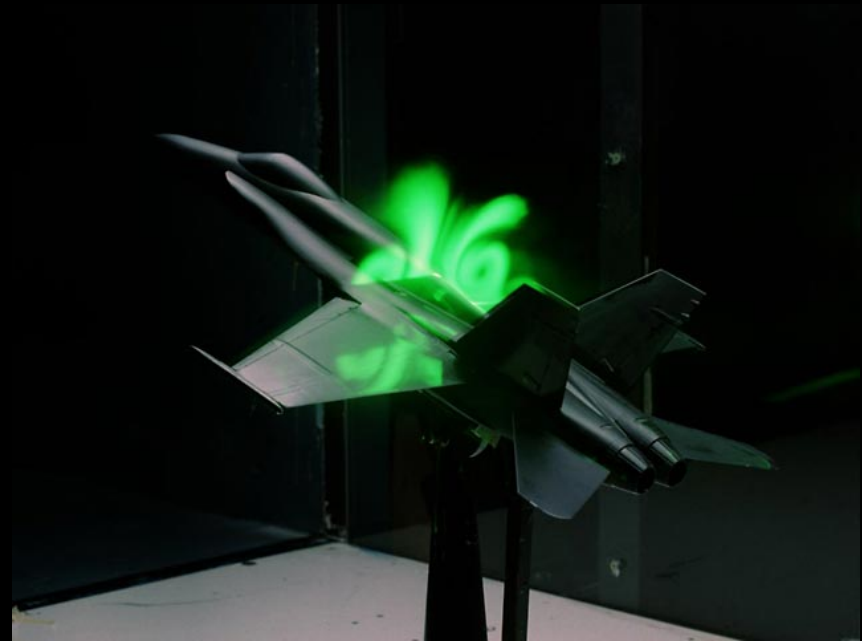
- All Class 4 and most Class 3b lasers get a safety permit
  - Safety procedures, facility layout, data table with MPEs and OD requirements for each laser
- Interlocks
  - These unfortunately are not fully standardized and most have been built in-house so they can be a bit quirky
- Audits
  - I visit each lab at least once a year, more often for most but only one visit is documented as an audit

# Program basics

- Worker certification
  - All Class 3b and 4 users get formal safety training
    - Class room lecture and exam
  - Initial laser eye exams
  - I cannot certify contractors but I do give them the training
- Annual refresher training
- We are looking at putting the laser training online

# Lasers in wind tunnels

- Flow visualization
- Particle Imaging Velocimetry
- Doppler Global Velocimetry
- Projection Moiré' Interferometry
- Planar Laser-Induced Fluorescence

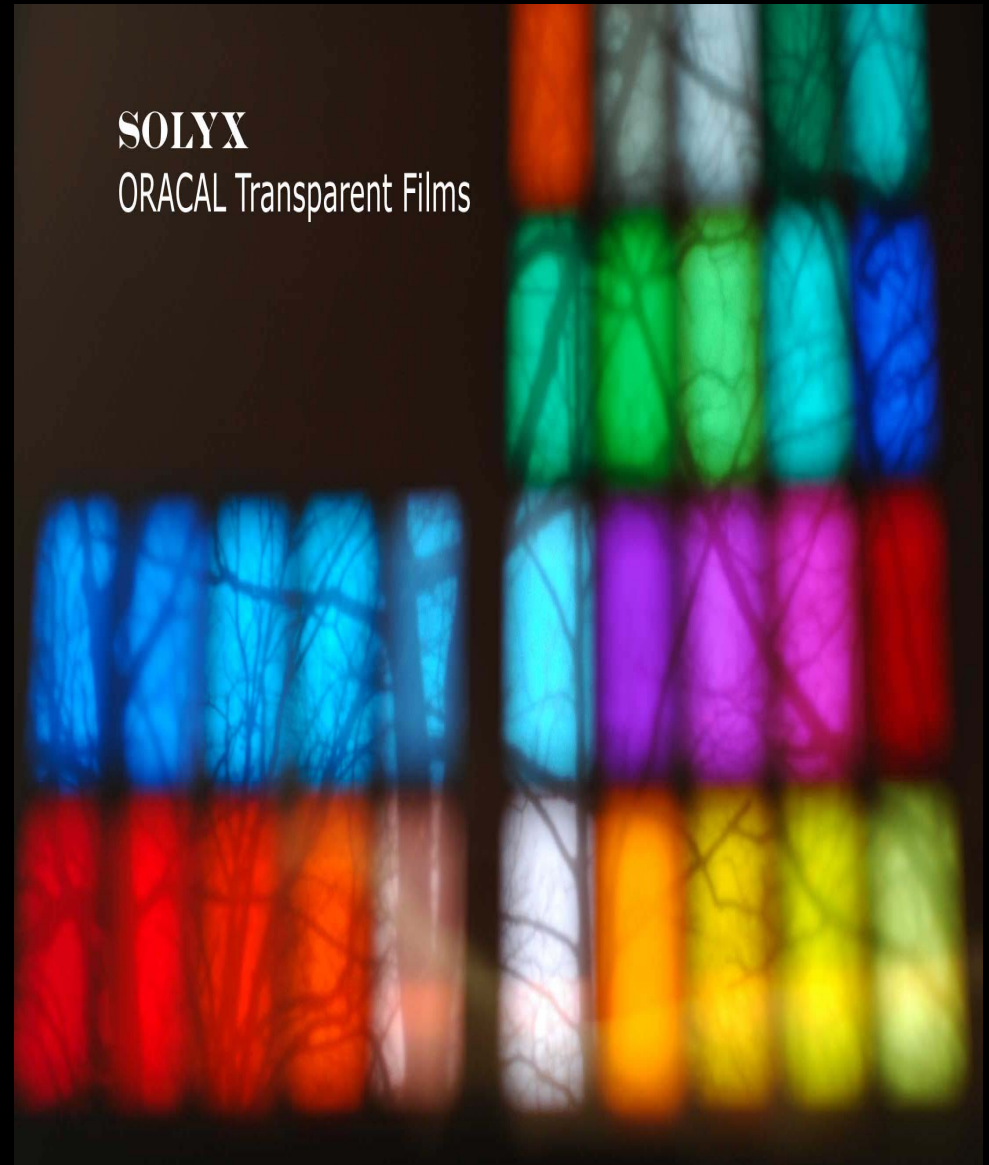


# Common wind tunnel controls

- Interlocks
  - Some wind tunnels do not have laser interlocks but have personnel safety interlocks due to other hazards
- Access controls and training of wind tunnel technicians
- Control rooms may require additional protection if they have viewing windows

# Window protection

- Architectural decorative window films
- Order samples in the colors you think will work
- Test in spectrophotometers
- Can usually get OD >3. Adequate for diffuse hazards



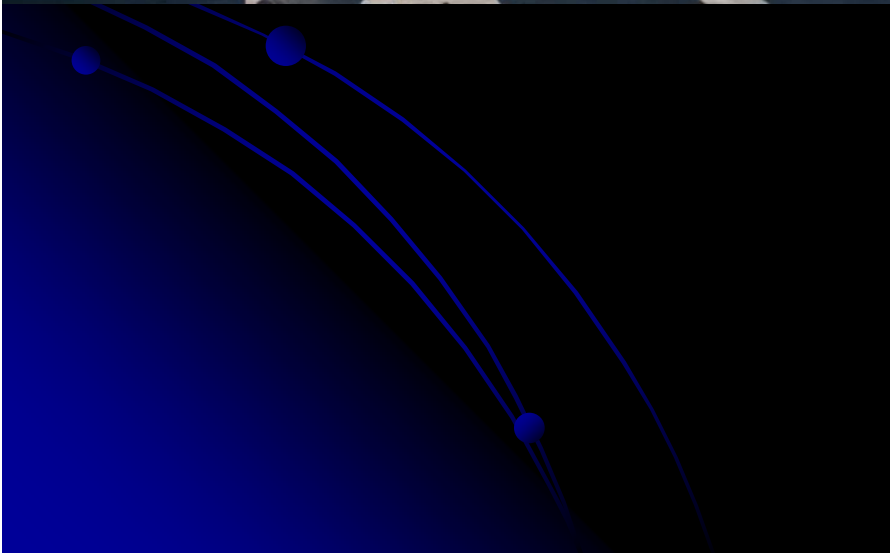
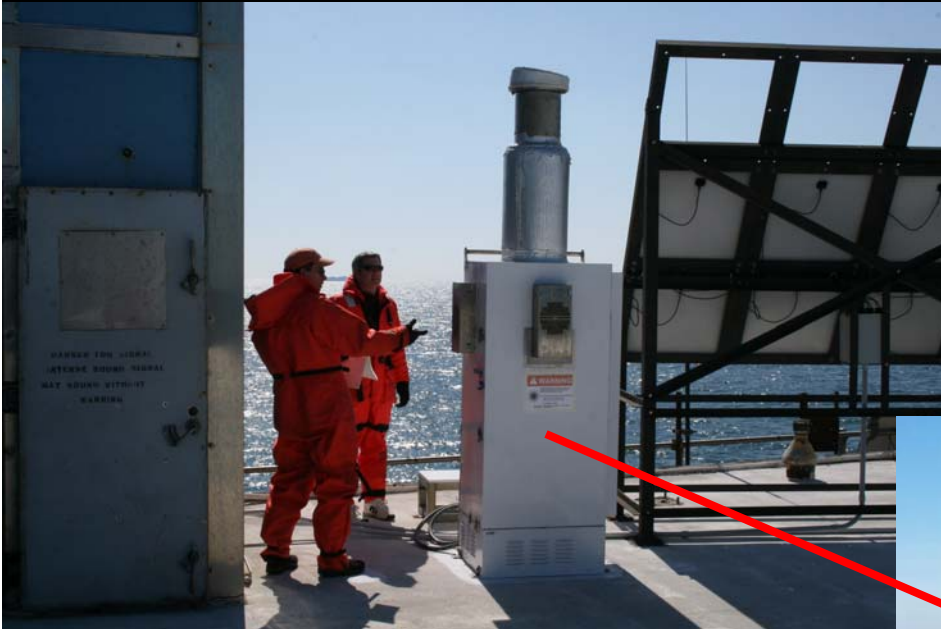
# Ground based lidar

- We have approximately 12 ground based lidars
- Some are portable and/or “flyable”, some are fixed and some are remote autonomous systems





# COVE MPL



# About MPL

- Class 2M autonomous lidar installed on the Chesapeake Light Tower, 14 NM out to sea.
- Runs 24 hours a day (unless broken) and controlled via wireless internet
- Annual visit by myself. There's tons of other hazards out there also so it's a full day inspection.
- FAA was provided a courtesy notification about its use but a formal review was not requested.

# How do you get there?



# On center lidar

- We have 7 laboratories set up for doing ground based lidar. 6 are vertical, 1 is horizontal
- Aside from normal lab controls such as interlocks we also utilize radar interlocks for aircraft detection when required.
- FAA and laser clearinghouse submissions, if required



# Examples



# Airborne lidar

- Many of our ground based systems are also designed to operate from aircraft
  - NASA DC-8, NASA King Air Be-200, L3 Comm. Lear Jet, Copmm. Helicopters
- Some transmit in only to zenith or nadir, some do both

# Airborne controls

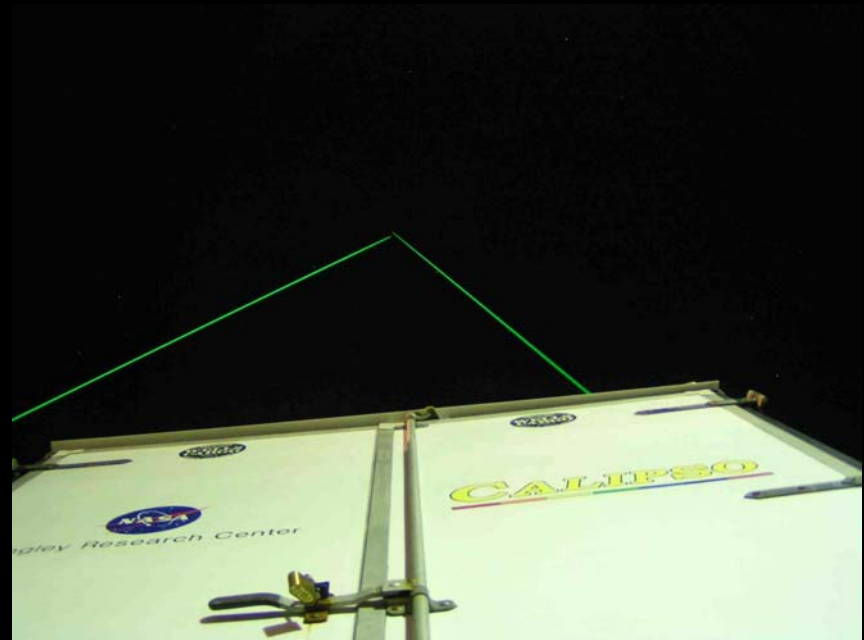
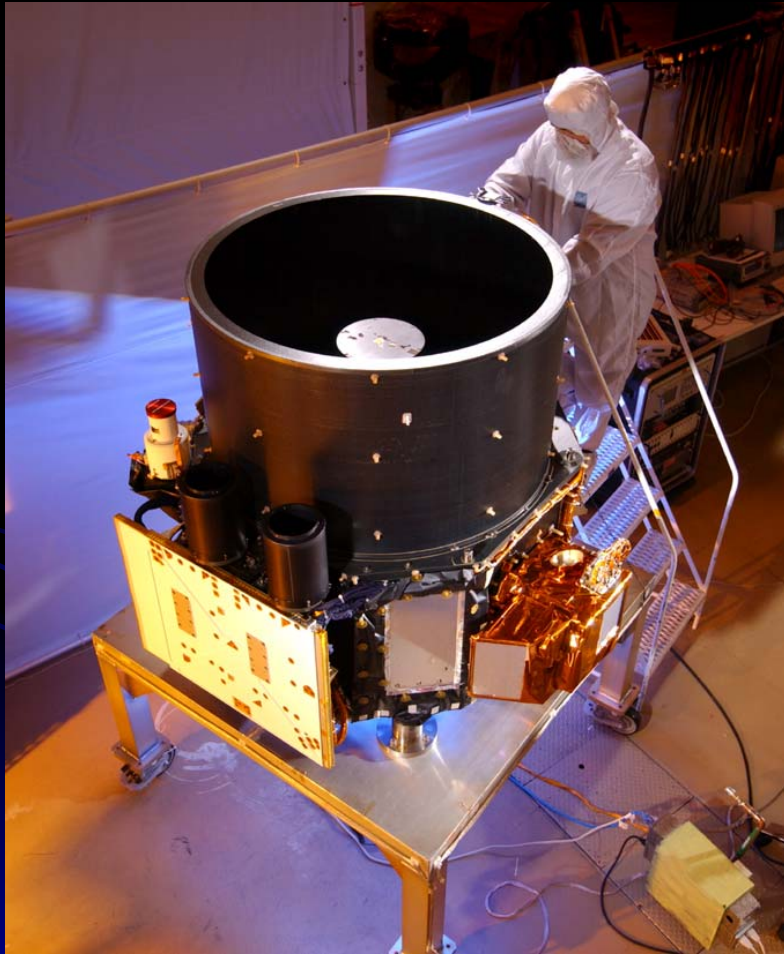
- Must be eye safe on ground
- TCAS radar if available
- Safety observers in the airplane
- Flight route to avoid overflying airports
- Flight safety review
  - Ensures buy-in from flight crews
- FAA submissions – These continue to be highly problematic

# Airborne lidars





# CALIPSO



It's in space now so no  
more worries right?



# WRONG!

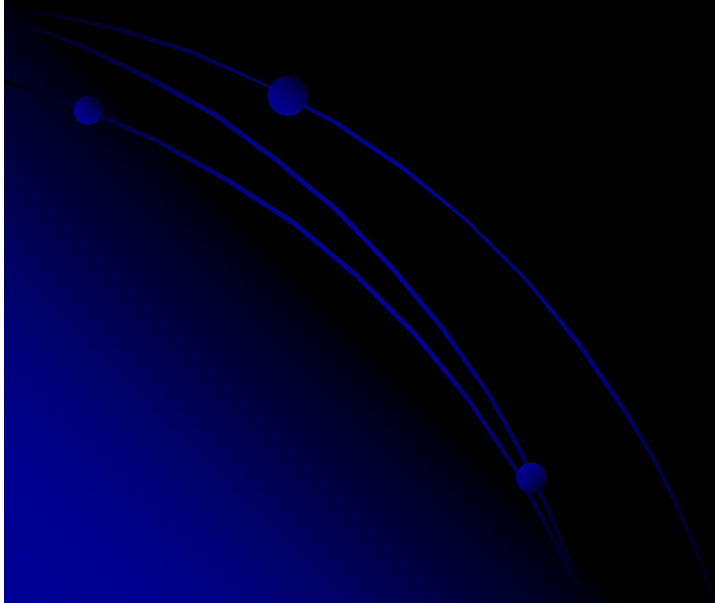
- Last year we started to hear rumors of people claiming to have been “exposed” to it
- Ground track data was available on line for science community
  - This allows you to know where it will be as well as where it was, so you could sit out there in the path and try to look at it
  - Although below MPE on the ground we did determine that there was a potential hazard if viewed with a telescope
- We altered the ground path information to reduce the accuracy. We made a conscious decision NOT to post a hazard warning on the CALIPSO web site.

You shouldn't be able to see  
something over 400 miles away right?





How do you explain something like  
this to management?





Altitude 438 miles

NOHD  
45.3 miles

385 miles



Altitude 40,000 ft.



# Problem areas

- FAA

- We continue to have issues with both the timeliness and overly restrictive outcomes

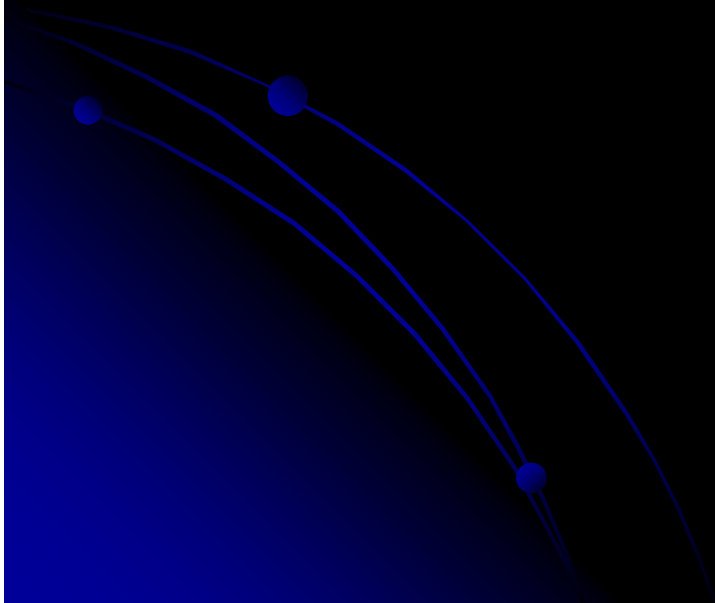
- Training

- I usually have about 1/4 of my laser workers out of date on refresher training

- New operations cropping up


- This is a recent phenomenon. Trained users are supposed to know that I have purchase control over laser systems.

# Laser hazard analysis software





# Experience

- I have been using Lazan for probably 10 years
  - I have been using LHAZ Ver. 4 for about 6 years
  - LHAZ Ver. 5 just came out (or has it)
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# Pro's

- Regardless of which you use it allows you do calculations quickly and with repeatable results
- If you take the time you can actually program all of your lasers into the software so you just pull it up and make changes as necessary
- You can disengage your brain and still get work done

# Con's

- Relying on the software alone leads to some knowledge atrophy in how the answers are derived
- The software may not be set up do to exactly what you need
  - FAA calcs
  - Mode locked pulse bursts
  - Multi wavelength lasers with fractional MPEs

# Lazan

- Relatively easy to use
- No aided viewing conditions
- Must add new lasers to the library if you are working with a wavelength that is not already programmed in
- Does have a nice print out report
- User defined laser data base is pretty nice if you decide to use it

# LHAZ Ver. 4

- Easy to use
- No need to add lasers, it just uses wavelength
- Ability to get NOHDs in different units
- Aided viewing as well as outdoor NOHDs with atmospheric attenuation
- Gives all MPEs in  $\text{mJ}/\text{cm}^2$ . Nothing really wrong with that but I prefer them in  $\text{mW}/\text{cm}^2$
- Graphing function never worked on my copy

# LHAZ Ver. 5

- Different layout from Ver. 4. I think it may be a bit harder to use but you have more parameters to play with (not always a good thing)
- The new graphing functions are nice
- Haven't had the work load to really try and break it yet